

FUELING THE FUTURE HYBRID & NATURAL GAS TRUCKS

SC **RECYCLING** & SOLID WASTE PROFESSIONALS CONFERENCE
OCTOBER 16, 2012



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ATV/AFV
SPECIALIST

**ADVANCED TECHNOLOGY VEHICLES?
ALTERNATIVE FUEL VEHICLES?**

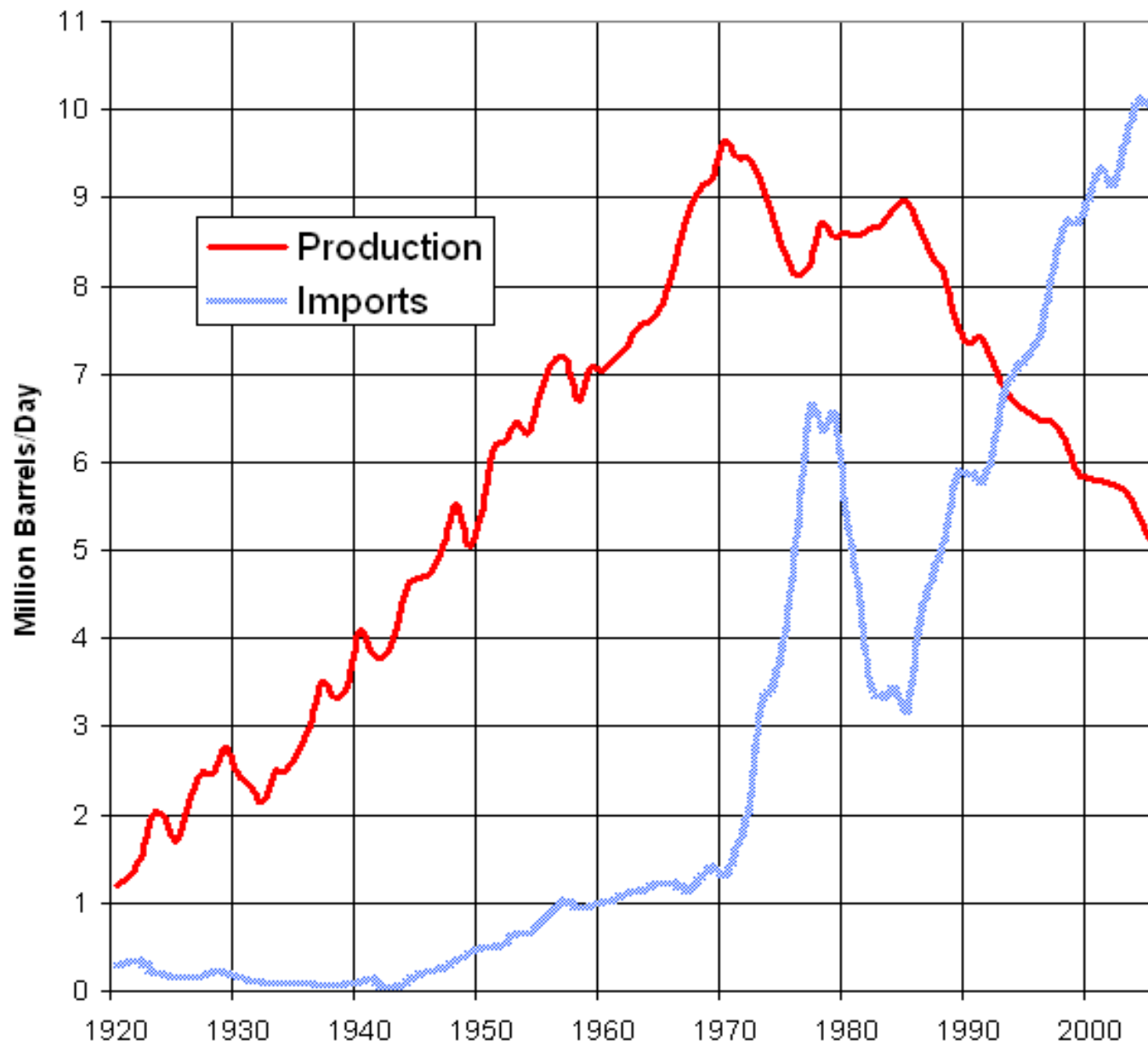
WHY CHANGE WHAT'S WORKING?



**REASON
ENOUGH?**

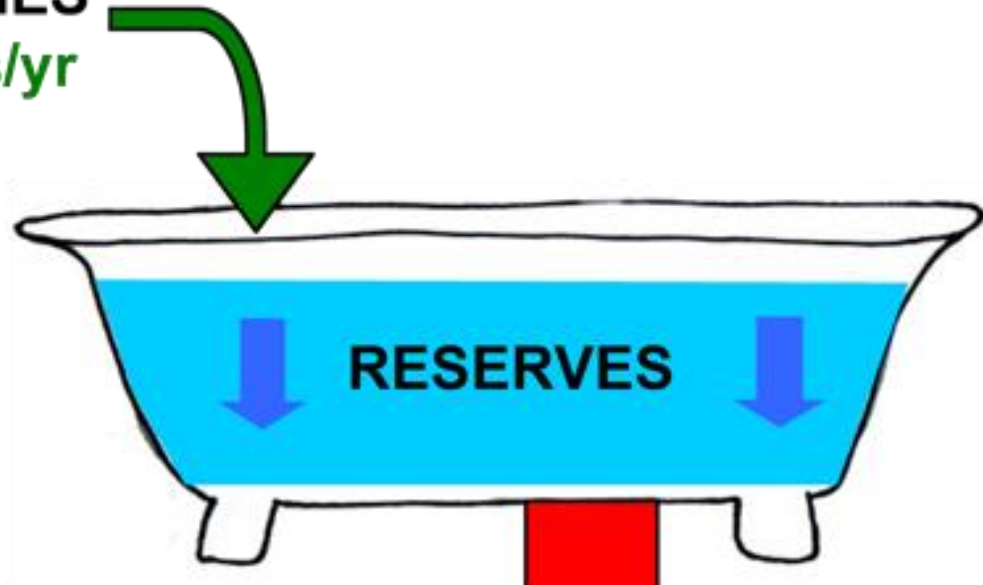
**HOW DID WE
GET HERE?**

US Oil Production and Imports



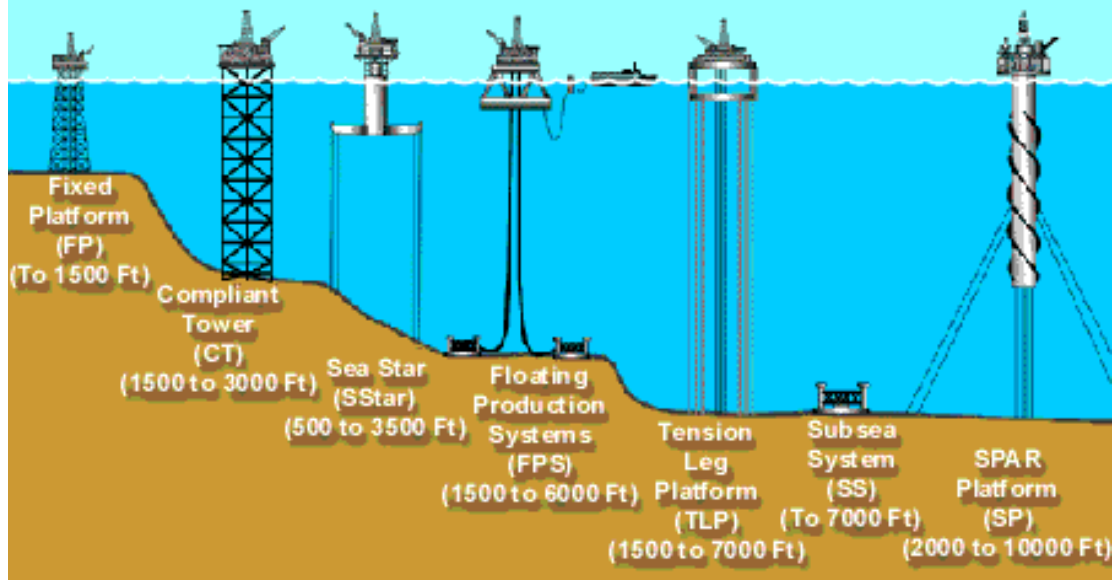
RESERVES DEPLETION

DISCOVERIES
6 B barrels/yr



PRODUCTION
31 B barrels/yr

DEEP OCEAN DRILLING



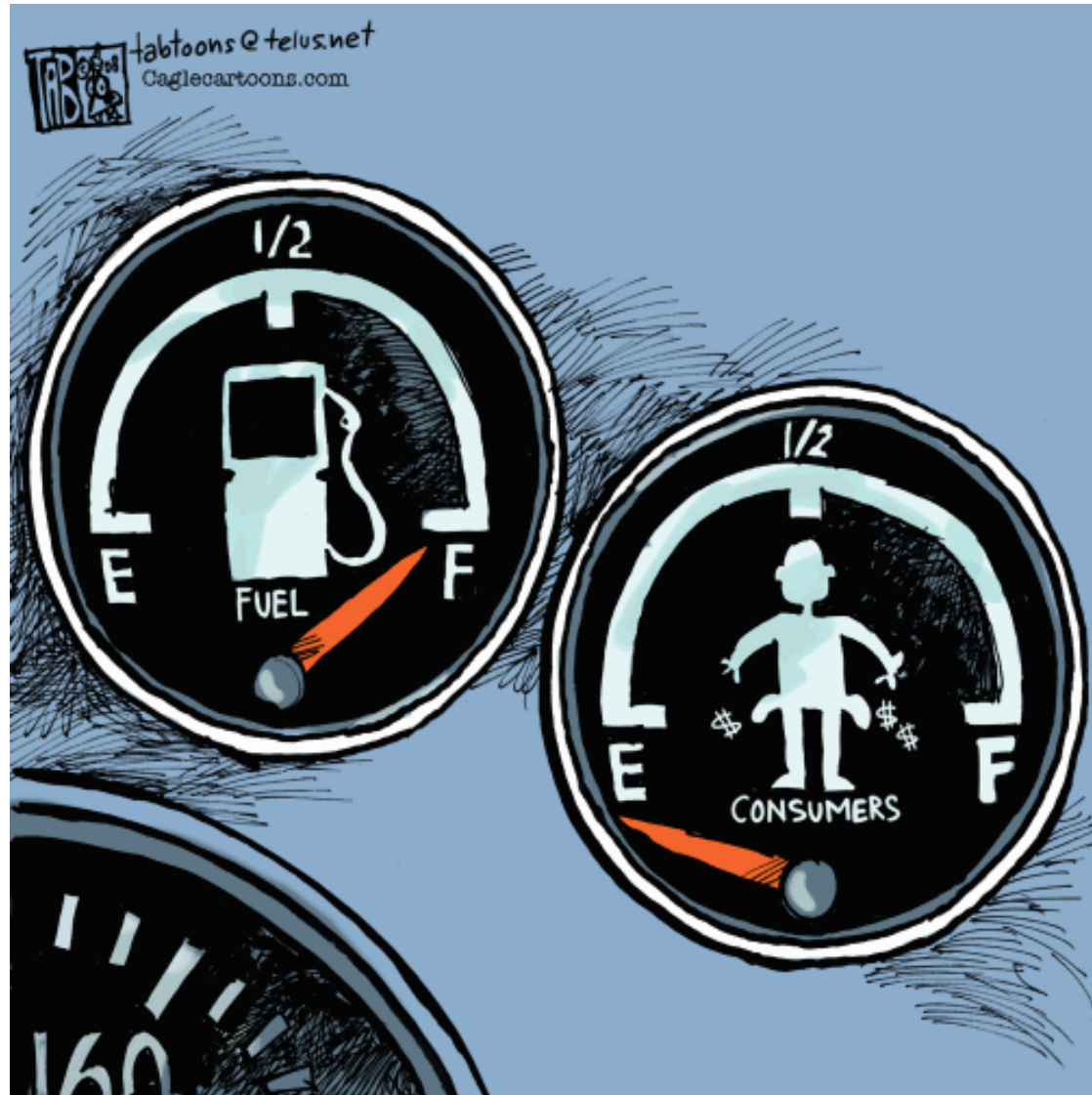
CANADIAN TAR SANDS



WHAT'S NEXT?



WHERE DO WE GO FROM HERE?





CAN YOU WORK WITHOUT DIESEL?

**THE BEST SOURCE
OF NEW ENERGY IS ?**

**THE BEST SOURCE
OF NEW ENERGY IS ?**

EFFICIENCY

Hydraulic Hybrid (HLA)



Hydraulic Launch Assist



INSERVICE 10-01-2010

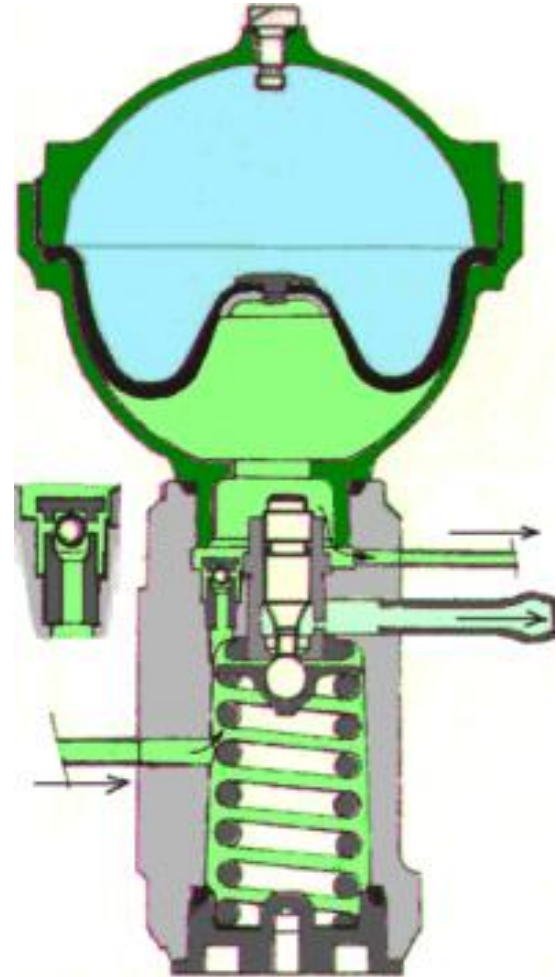
HLA OPERATION

KINETIC: WORKING, MOVING ENERGY



HLA OPERATION

POTENTIAL: STORED, NON MOVING

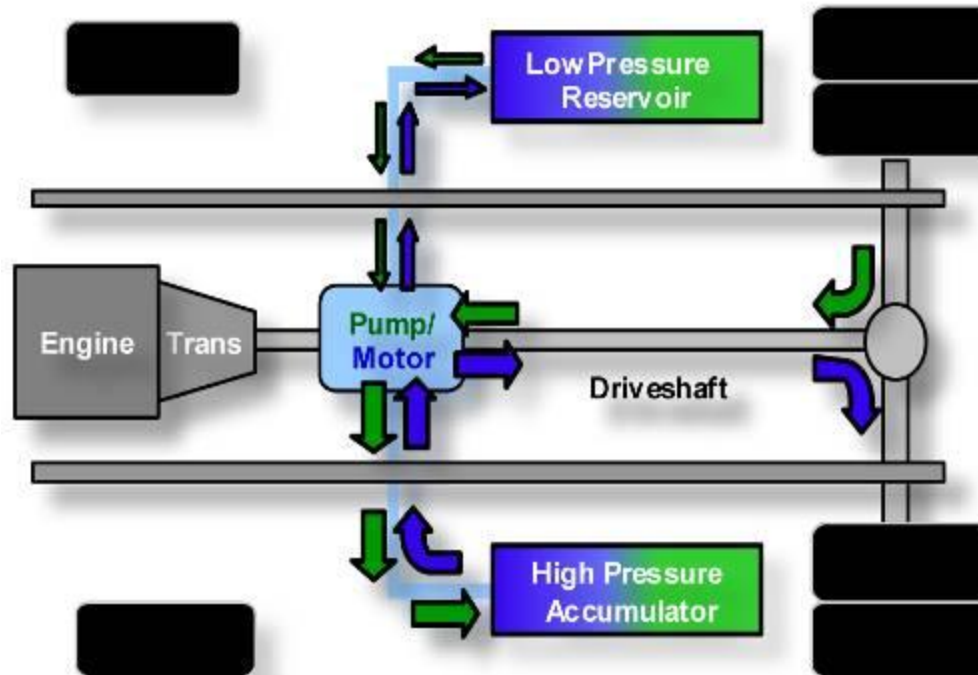


HLA OPERATION

MOVEMENT OF ENERGY

CAPTURE

RELEASE



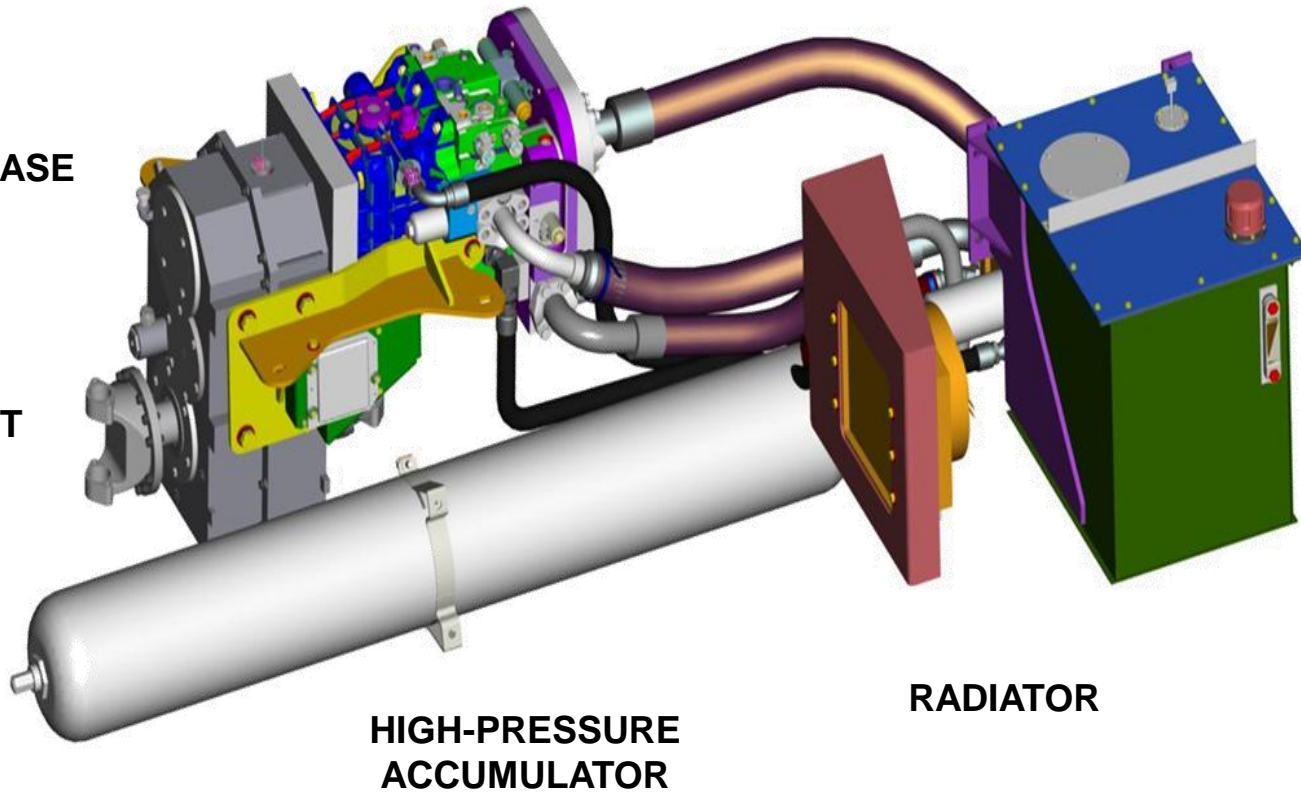
HLA COMPONENTS

PUMP/MOTOR

RESERVIOR

TRANSFER CASE

DRIVE SHAFT
COUPLING

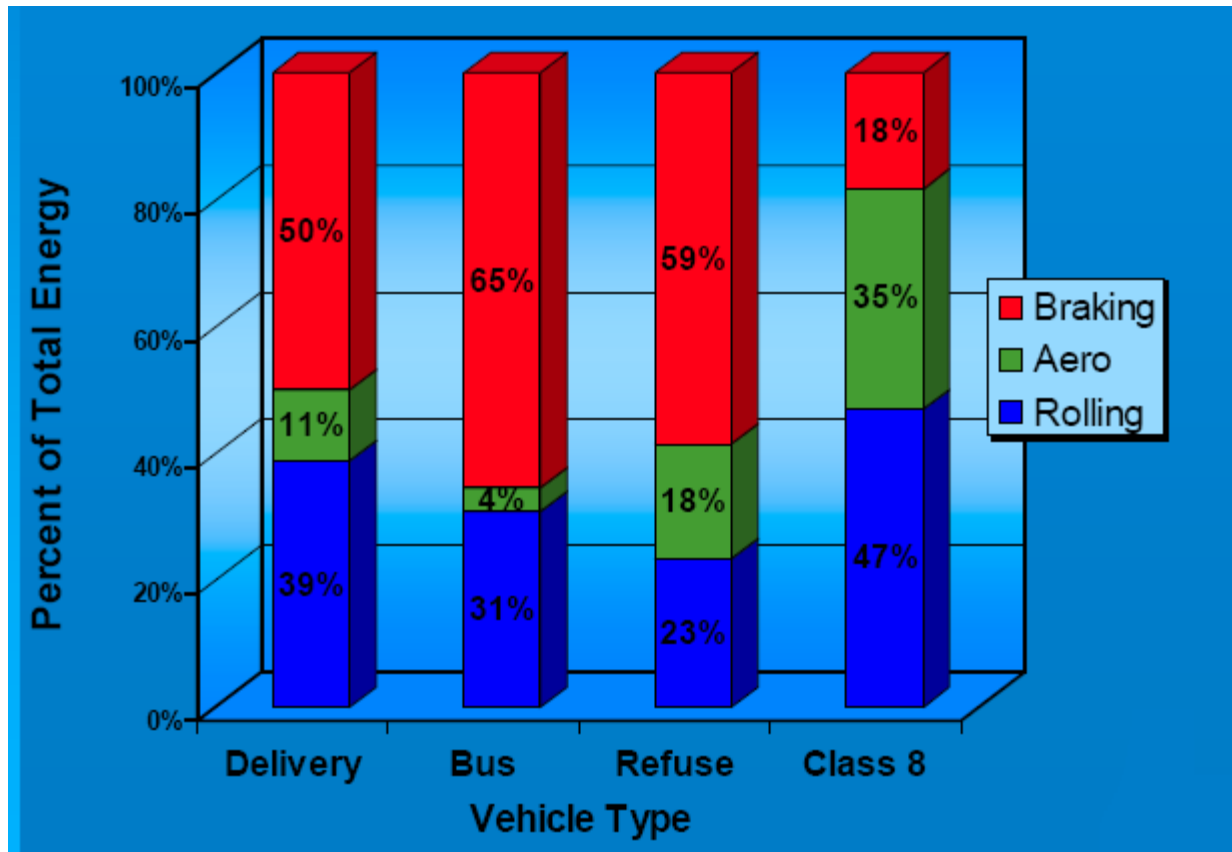


ENERGY CONSUMPTION BY TRUCKS

STARTING

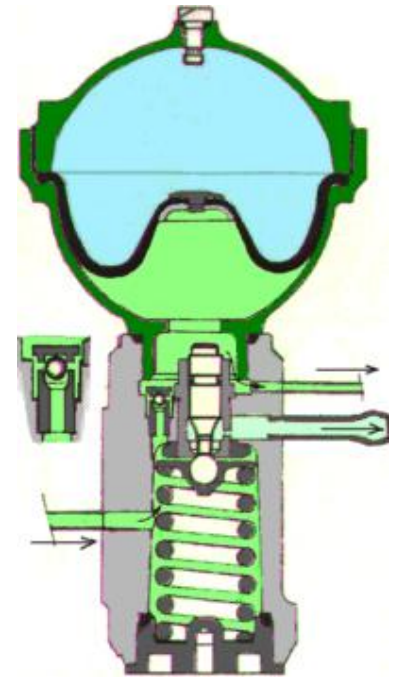
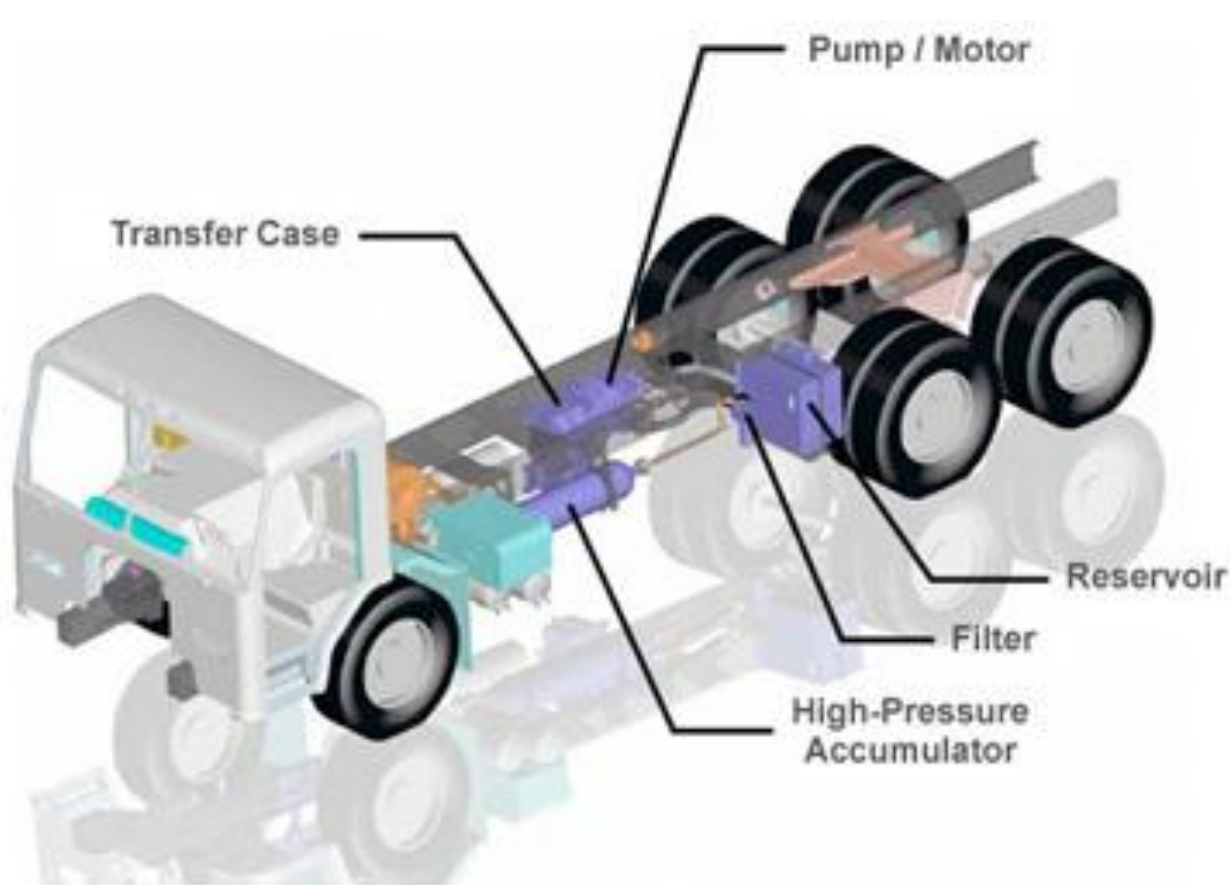
NEUTRAL

STOPPING



PRESSURAZITION

The hydraulic fluid compresses nitrogen gas in the accumulator and pressurizes the system to a maximum pressure of 5,000 PSI. The regenerative braking captures about 70% of the **KINETIC** energy produced during braking & turns it into **POTENTIAL** energy.



REDUCED BRAKE WEAR

Capturing 70% of the braking energy with the hydraulic fluid can reduce brake wear by more than 50%. The HLA system prevents service brake application till just before a complete stop.

Heavy refuse trucks may need 2 or more brake jobs per year. This system could stretch the life of one brake job to well over 1 year.

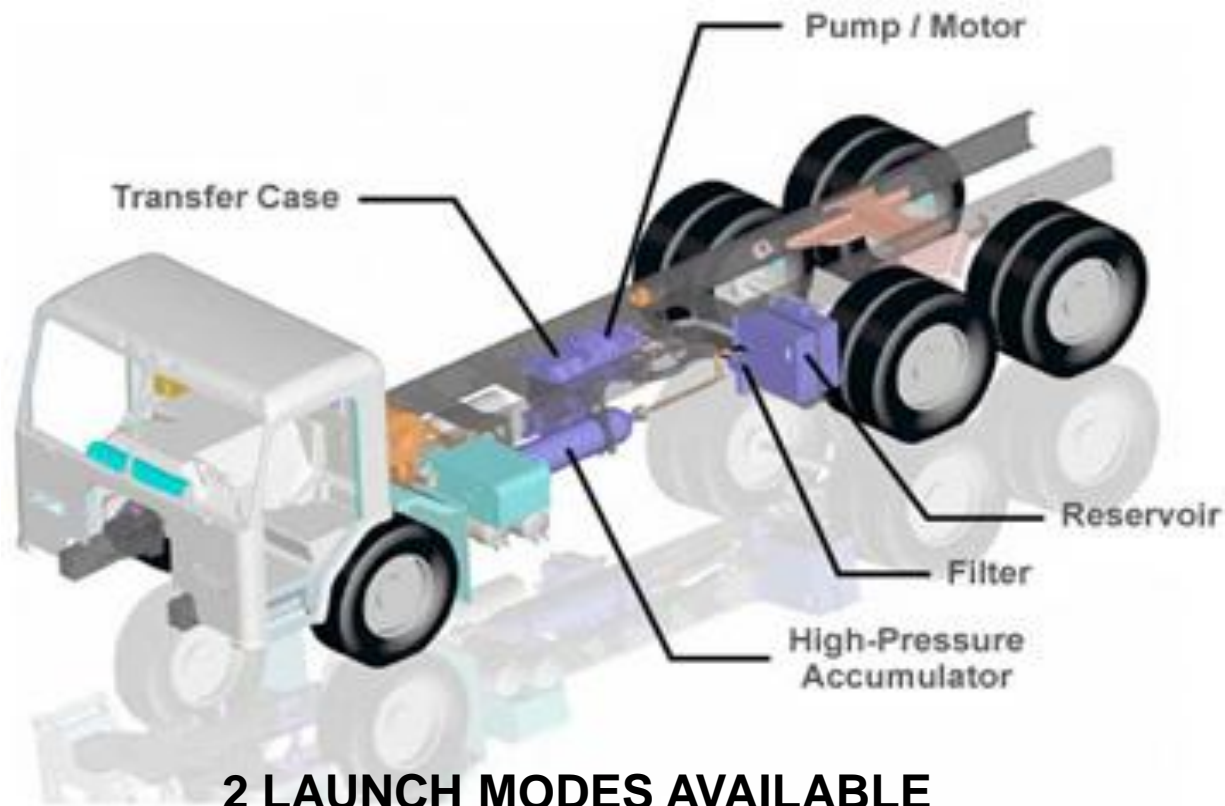
An average brake job may cost \$3500.00 x twice per year X 8 years service life = \$56,000.00

One brake job every year x 8 years service life = \$28,000.00

\$28,000.00 savings through reduced brake wear over 8 years

LAUNCH ASSIST

During acceleration, fluid in the high-pressure accumulator is metered out to drive the pump/motor as a motor. The system propels the vehicle by transmitting torque to the driveshaft.

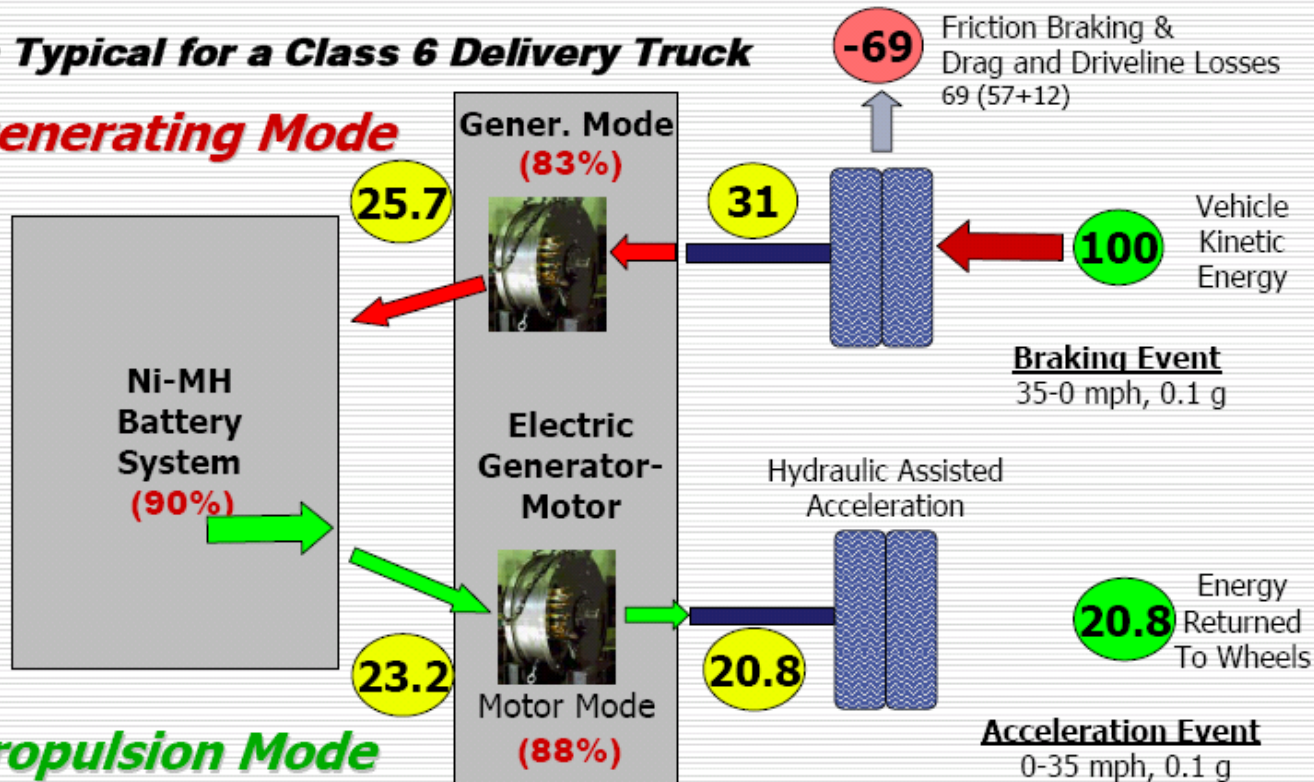


Electric Efficiencies

Efficiencies While Braking/Accelerating Electrically

Data Typical for a Class 6 Delivery Truck

Regenerating Mode

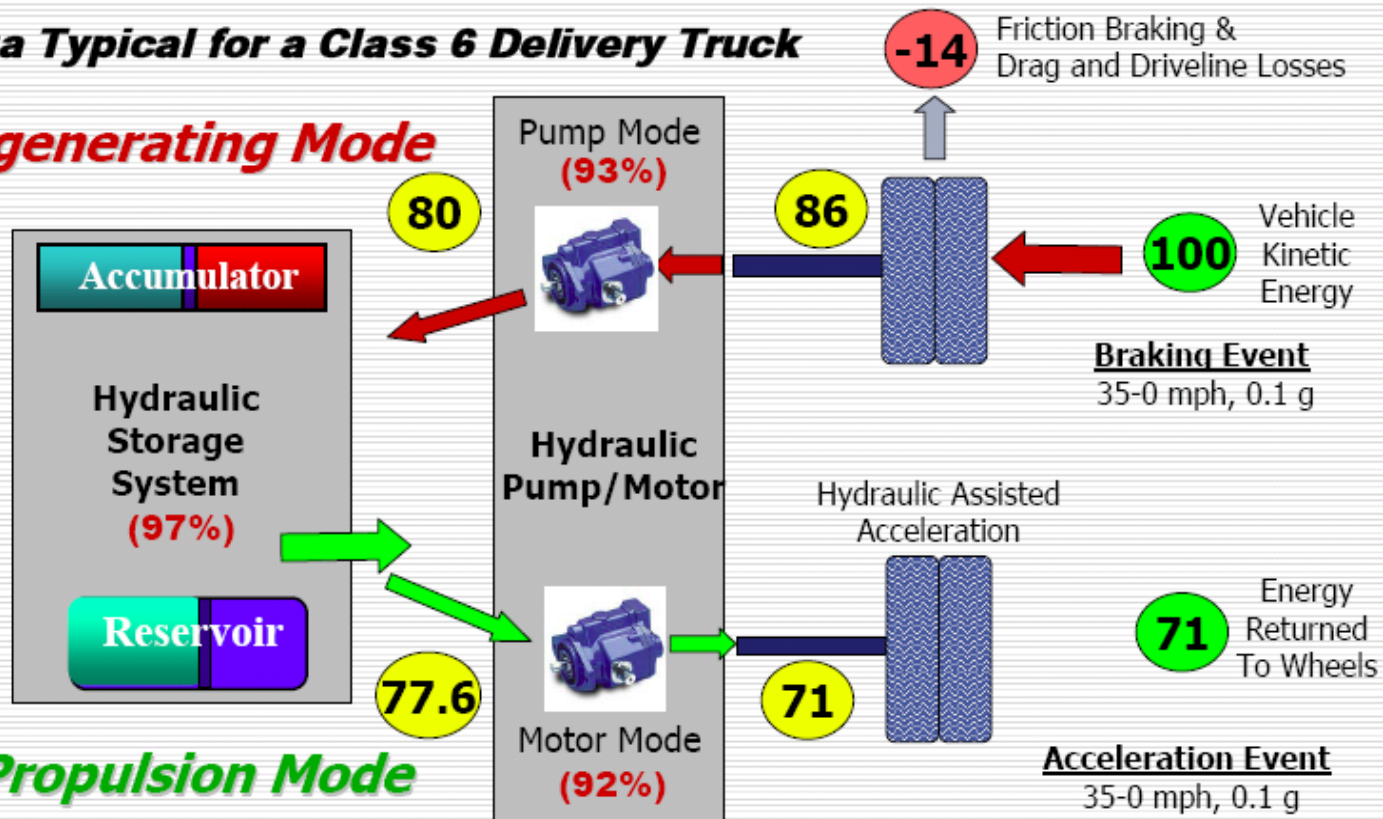


Hydraulic Efficiencies

Efficiencies While Braking/Accelerating Hydraulically

Data Typical for a Class 6 Delivery Truck

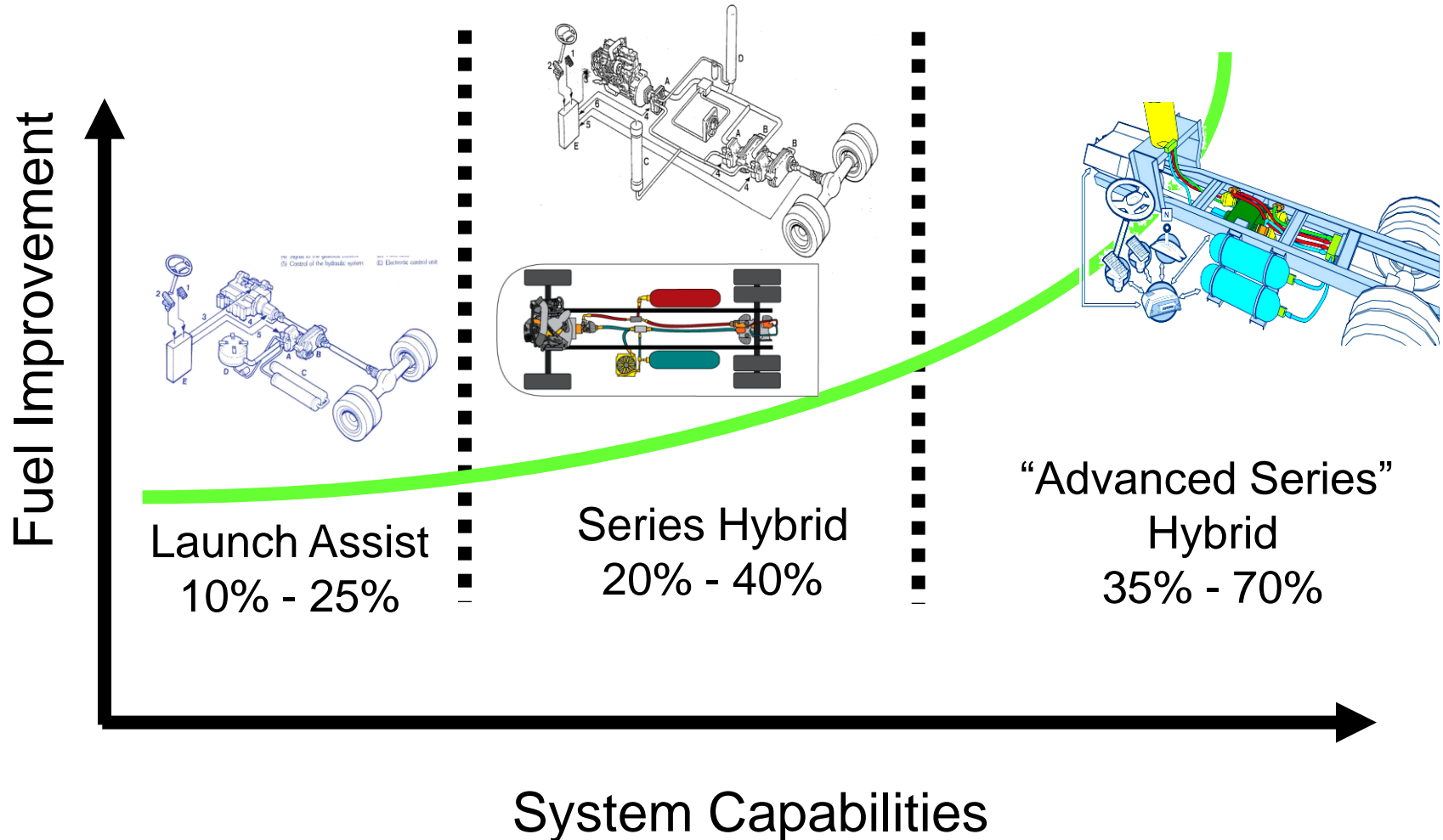
Regenerating Mode



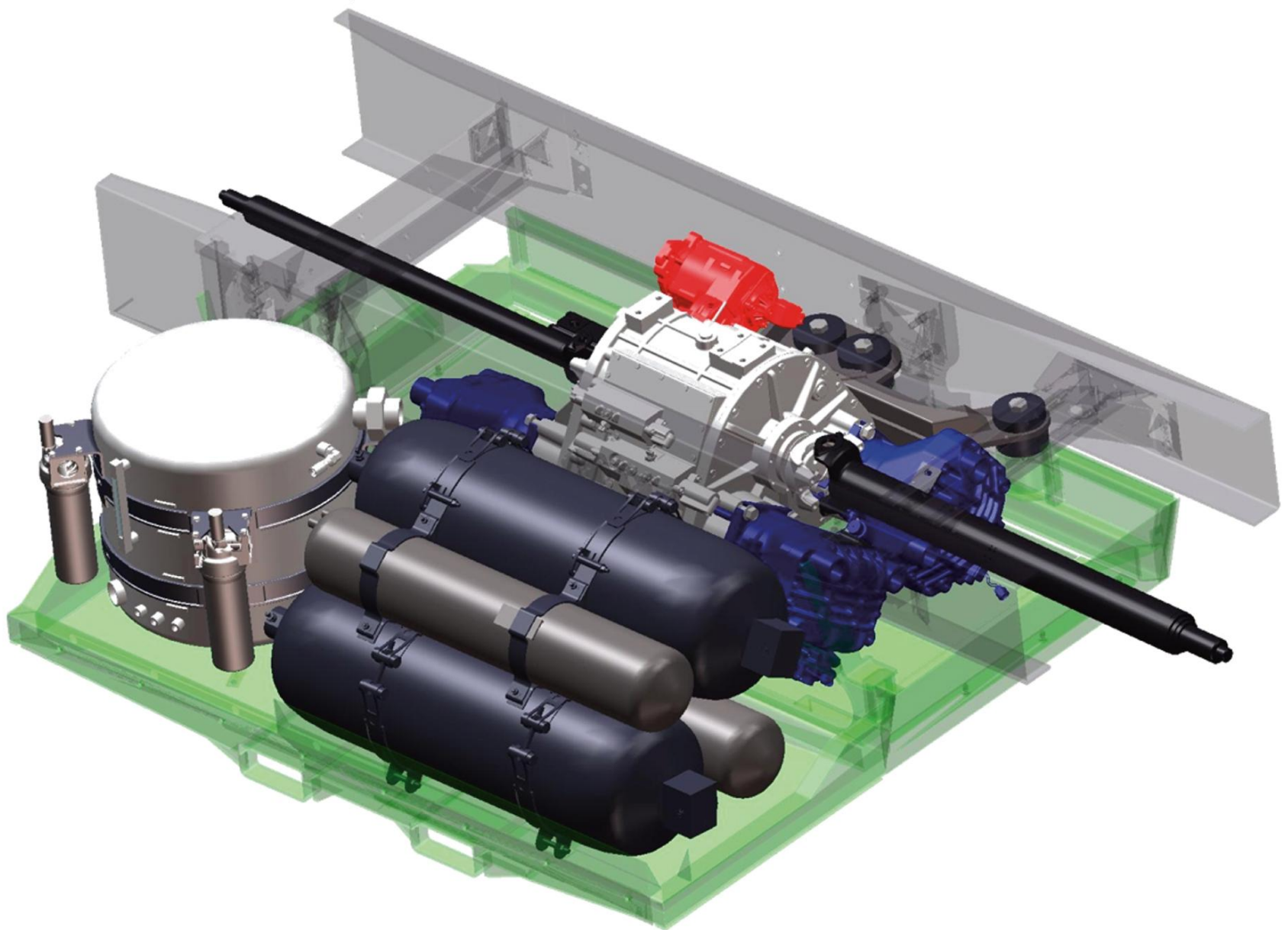
Propulsion Mode

HYDRAULIC HYBRID TECHNOLOGY COMPARISON

Fuel Savings relative to Competitors



RunWise™ Hydraulic Hybrid System



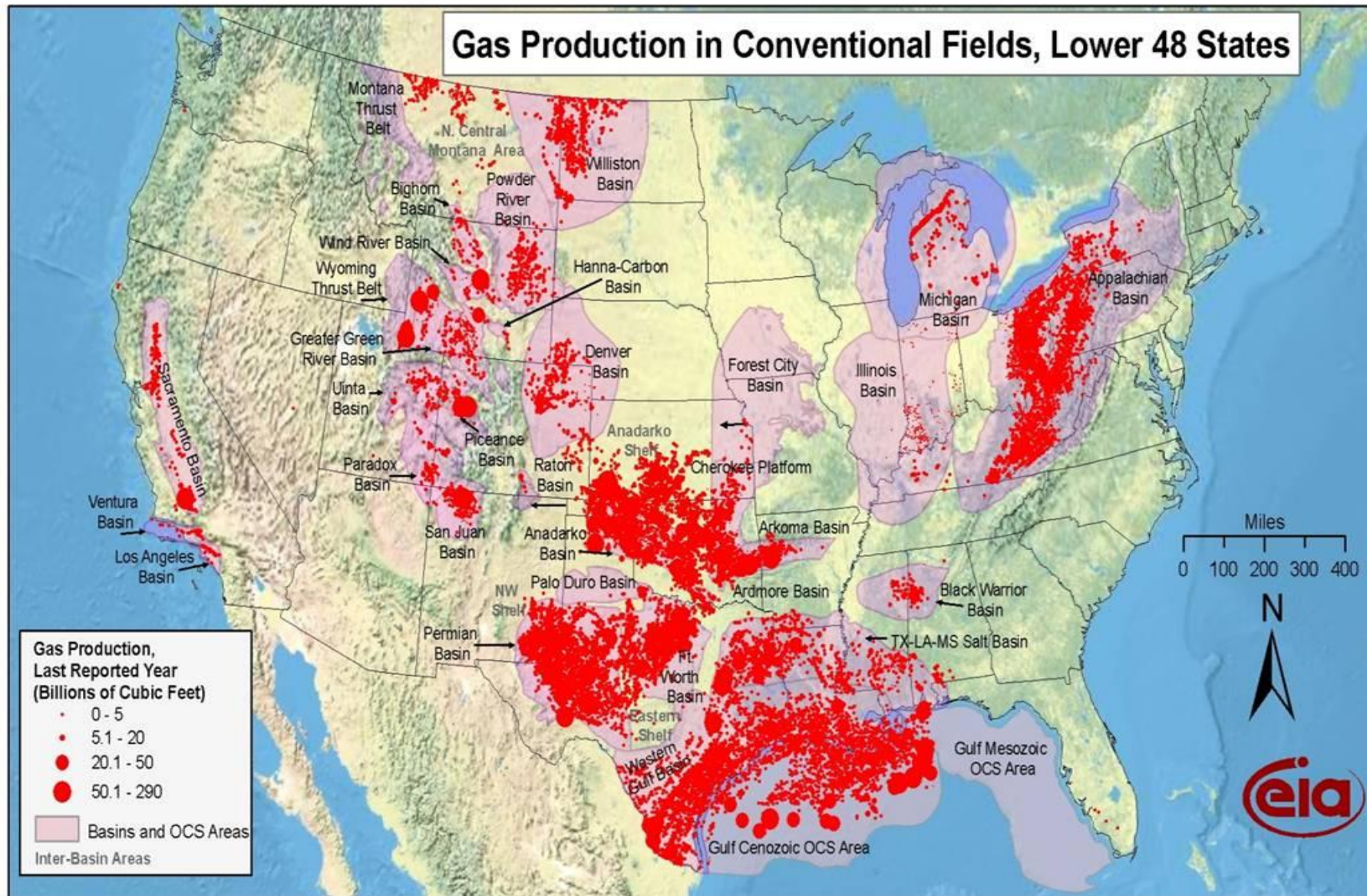
WHY NATURAL GAS?

- **U.S. MADE FUEL**
- **DISTRIBUTION SYSTEM IS IN THE GROUND**
- **LESS THAN ½ CURRENT COST OF DIESEL**
- **SAVINGS OF OVER 20 CENTS / MILE OVER DIESEL**
- **AVERAGE 20-25% REDUCTION IN GHG EMISSIONS**
- **EXCEEDS 2010 DIESEL EMISSION REQUIREMENTS WITH 2002 TECHNOLOGY**
- **LOWEST CARBON EMISSIONS OF ALL ENGINES**

BTU CAPACITY OF FUELS

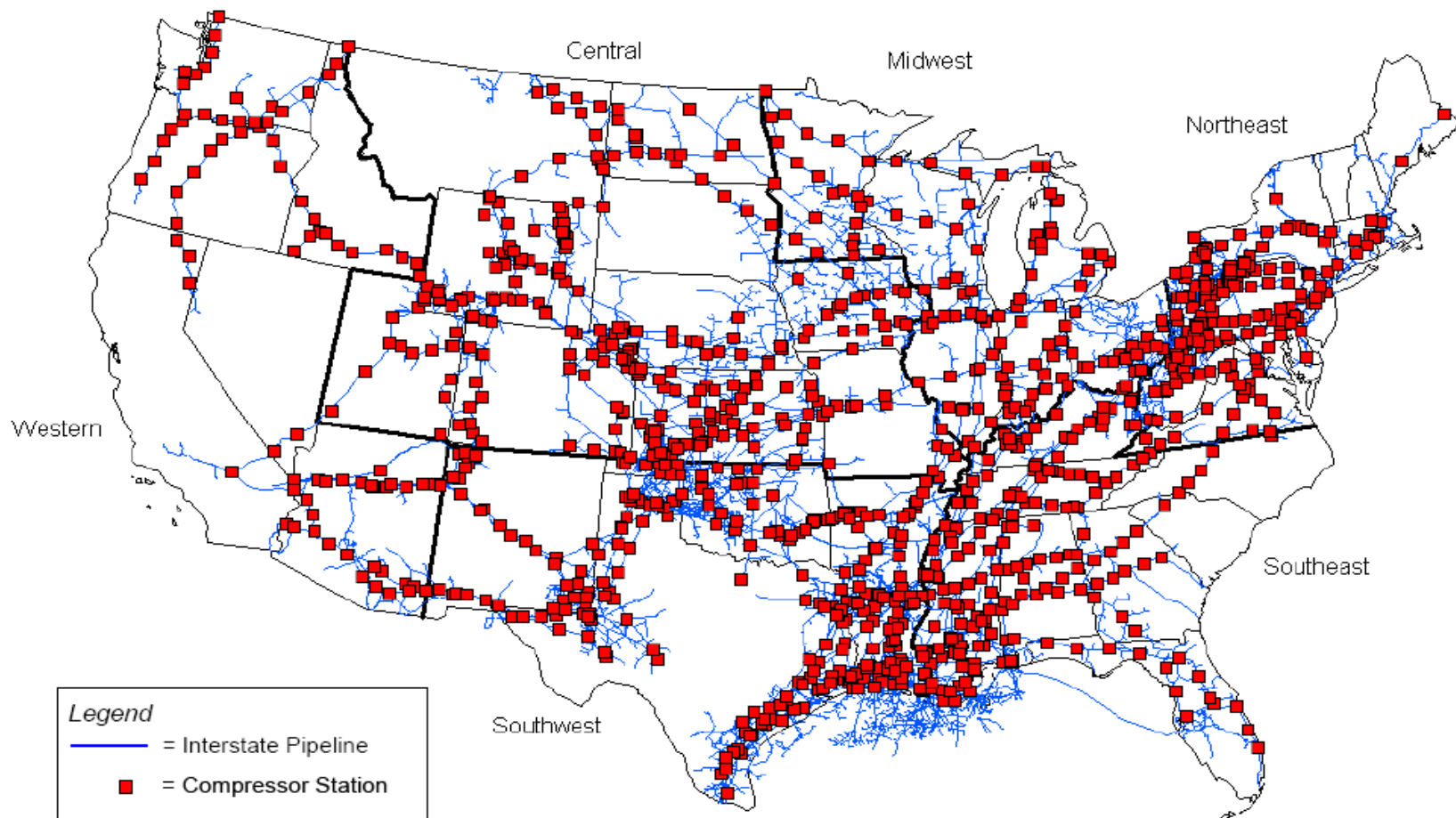
# Carbons	Name	Structure
1	methane	$ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array} $
2	ethane	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} $
3	propane	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $
4	butane	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $
5	pentane	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $
6	hexane	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $
7	heptane	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $
8	octane	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} $

Gas Production in Conventional Fields, Lower 48 States

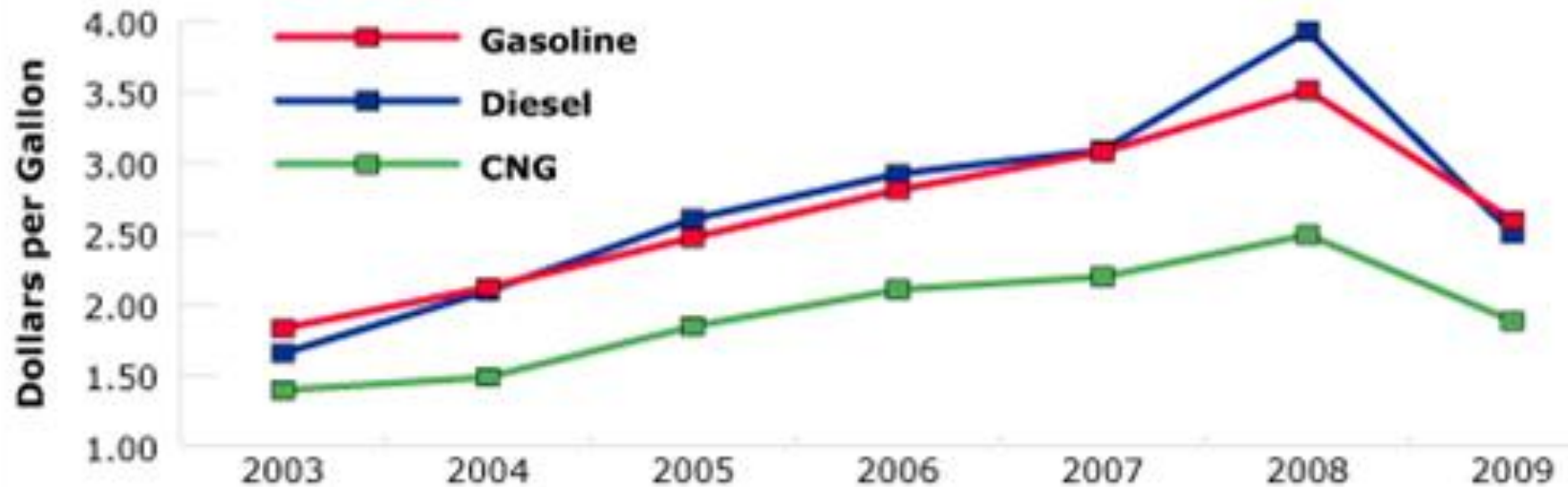


Source: Energy Information Administration based on data from HPDI, IN Geological Survey, USGS
Updated: April 8, 2009

US Interstate Natural Gas Pipeline & Pumping Stations

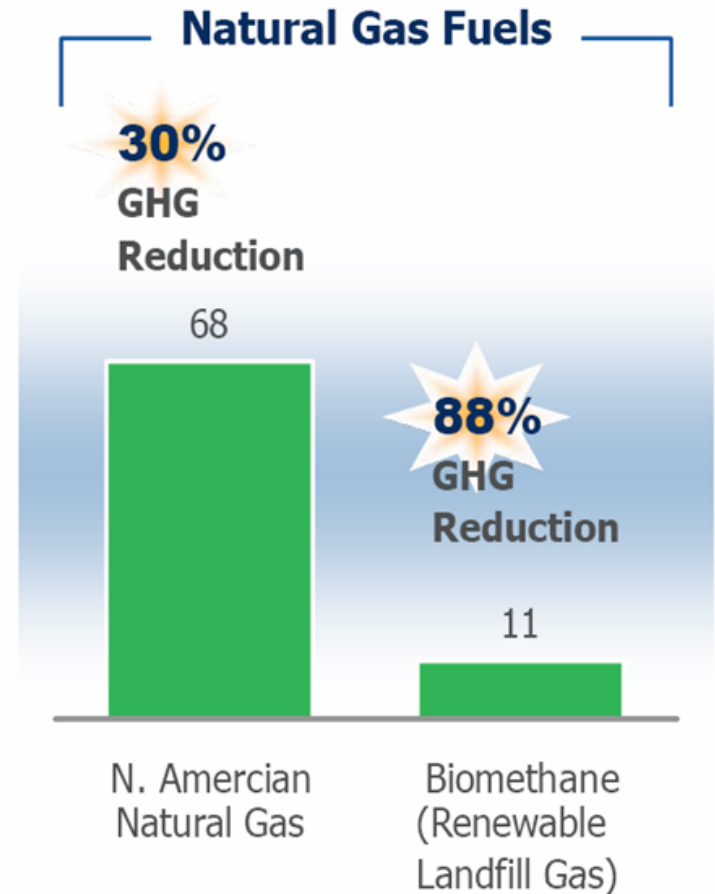
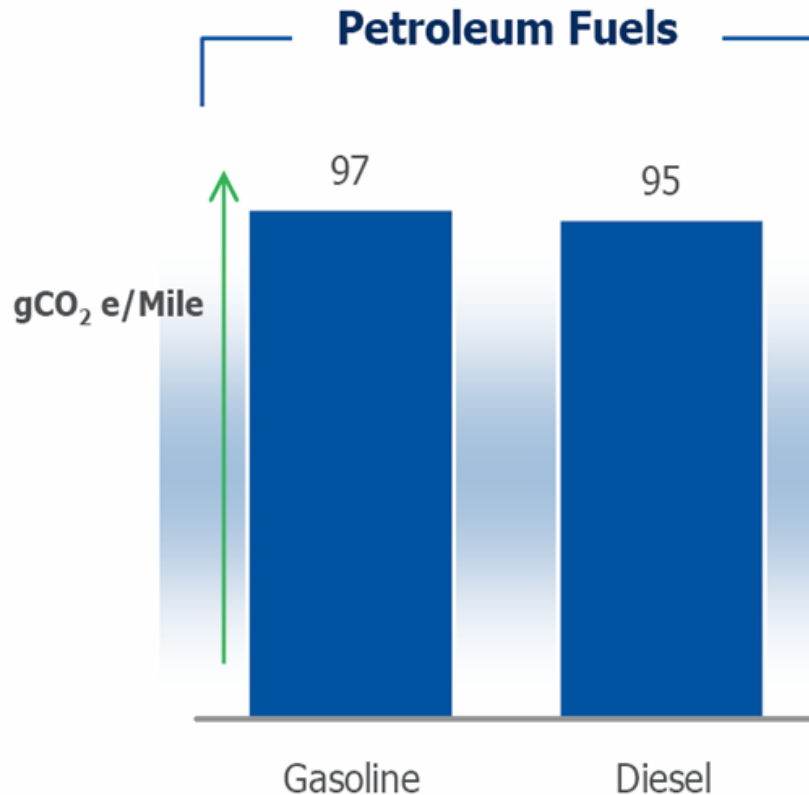


Gasoline, Diesel and CNG retail price comparison



Source: U.S. Energy Information Administration (Feb 2010)

GHG EMISSION REDUCTIONS



Nationalwide Summary	
558 OPERATIONAL Projects (1,727 MW and 312 mmscfd)	OPERATIONAL PROJECTS
~510 CANDIDATE Landfills (1,170 MW or 590 mmscfd, 13 MMTCE Potential)	CANDIDATE LANDFILLS*

* Landfill is accepting waste or has been closed for 5 years or less, has at least 1 mmtons of waste, and does not have an operational/under construction LFG energy project; or is designated based on actual interest/planning.

These data are from LMOP's database as of July 11, 2011.

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BMW SPARTANBURG SC BIO-METHANE POWER PLANT

Using landfill methane to provide electrical power to plant



**Can be cleaned up & used as transport fuel.
Sale of Carbon Credits will pay for equipment**

WHO'S USING NATURAL GAS?

**CITY OF CHARLOTTE
6 CNG AUTOCAR
4 MORE ON ORDER**



**GOD BLESS THE USA
2 INTERNATIONAL
1 MACK
CNG RECYCLE TRUCKS**

WHO'S USING NATURAL GAS?



**FRITO-LAY
CHARLOTTE PLANT
10 FREIGHTLINER
CNG TRACTORS**

**PIEDMONT NAT GAS
PETERBILT
CNG DUMP TRUCK**



WHO'S USING NATURAL GAS?



**ALLBRIGHT SANITATION
COLUMBUS NC
3 FREIGHTLINER
4 AUTOCAR
3 MACK
CNG GARBAGE TRUCKS**

**TIME FILLED
CNG STATION
(PRIVATE)**



WHO'S USING NATURAL GAS?



HONDA CNG FUEL TANK



CUMMINS ISL-G



**SURPASSES 2010
EPA DIESEL
EMISSION
STANDARDS**

- NO DOC
- NO DPF
- NO DEF

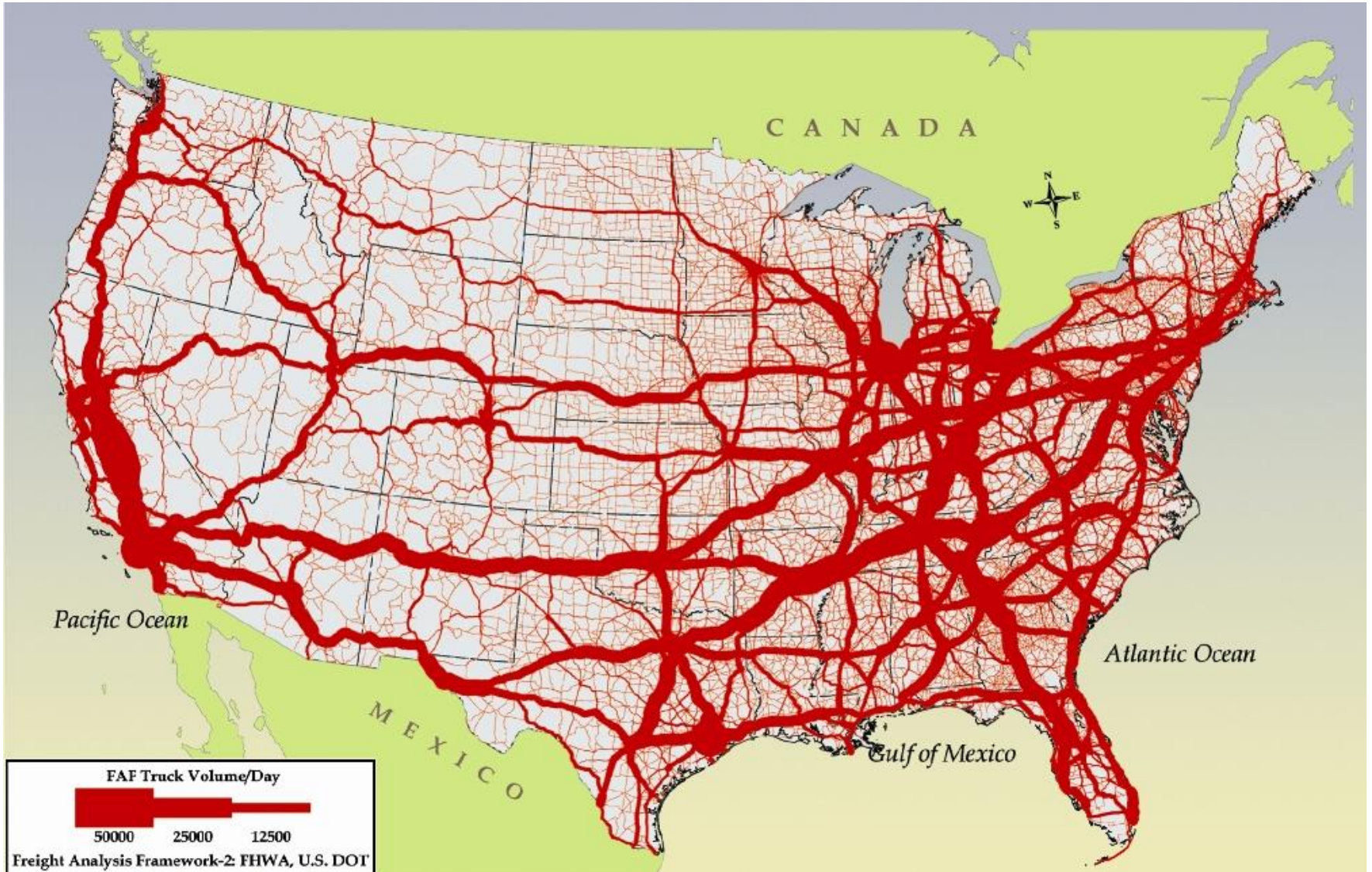
320 HP (max)



LIQUIFIED NAT GAS (LNG)
-260°F
SHIPPED BY
TRUCK



U.S. HIGHWAY TRUCK TRAFFIC



America's Natural Gas Highway

2012-2013 LNG Fueling Station Network



150 STATIONS
\$450 MILLION INVESTMENT



CNG/LNG STATION L.A. PORT



**WHAT WILL THE FUTURE
FLEET & FUELING LOOK LIKE?**

NG WORKS FOR ME



LET'S GET STARTED